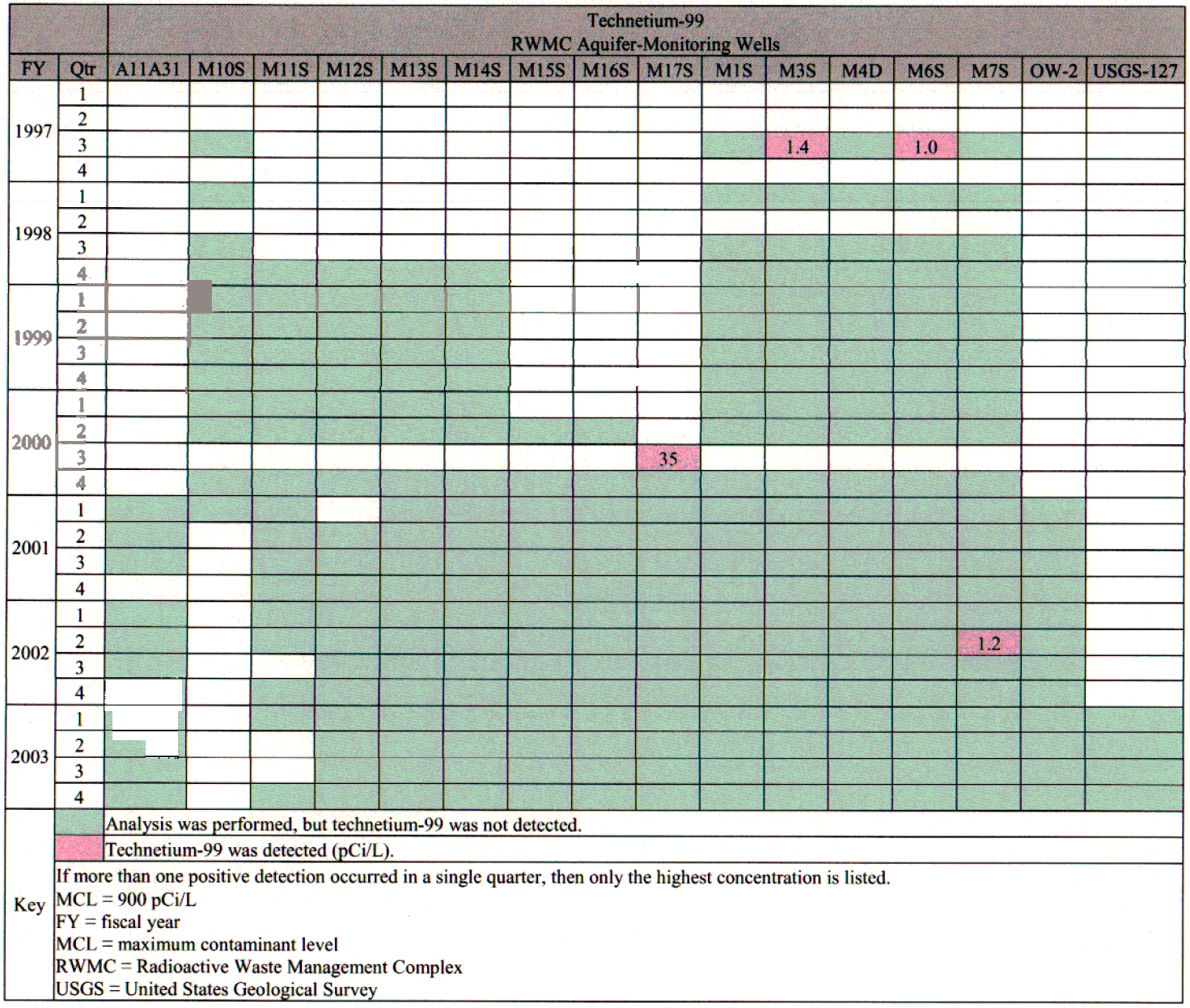

Figure 3-46. Occurrences of technetium-99 in aquifer samples collected in the vicinity of the Radioactive Waste Management Complex since Fiscal Year 1997.

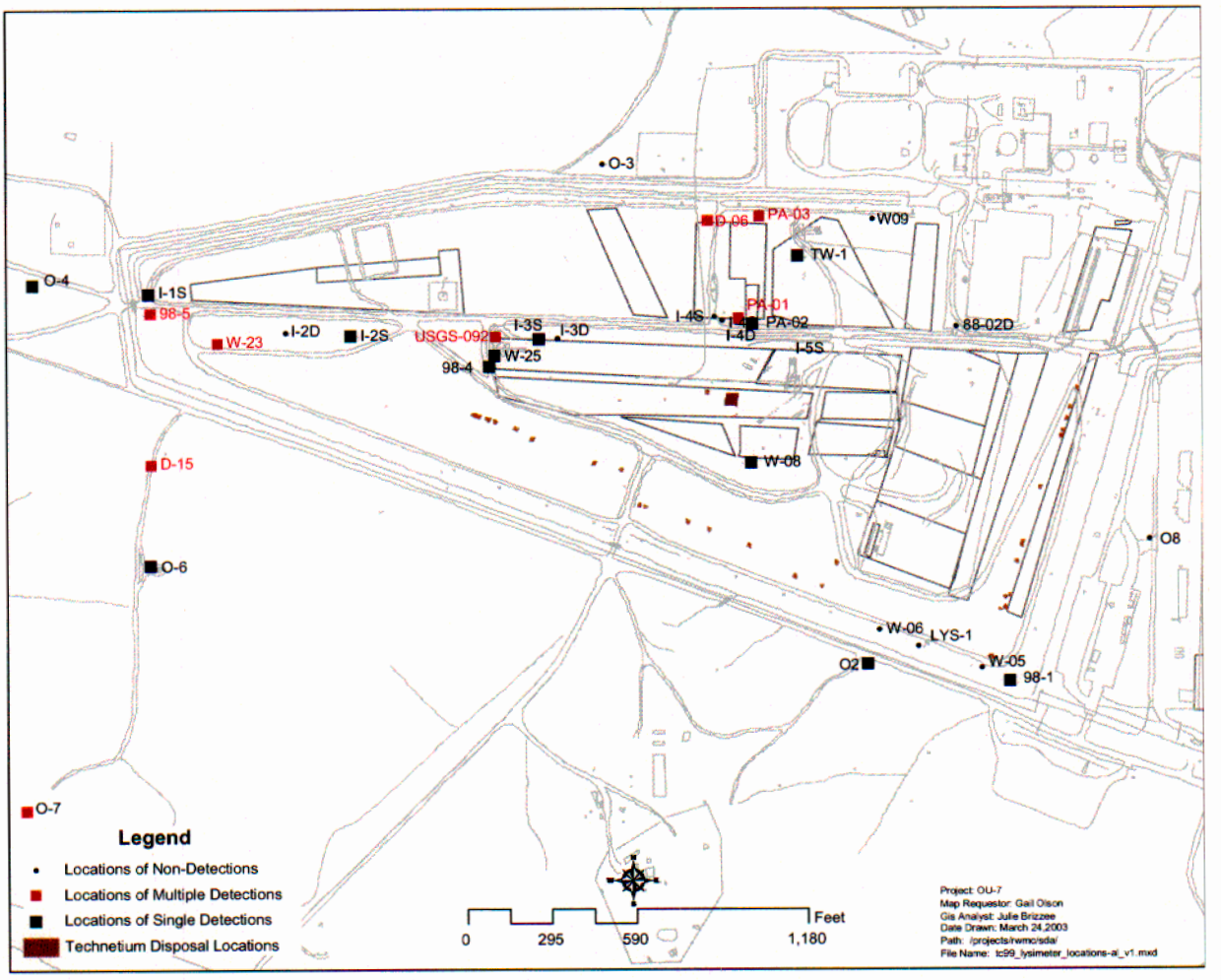

Figure 3-47. Disposals and vadose zone detections of technetium-99.

3.10 Uranium

Uranium occurs naturally in the environment and is processed and handled for use in nuclear weapons and reactors. Because several isotopes are naturally occurring, it is necessary to differentiate background concentrations from anthropogenic uranium. Background concentration guidelines for U-234 and U-238 in the aquifer beneath the RWMC are 1.9 and 0.9 pCi/L, respectively (Leecaster, Olson, and Koeppen 2003), and the background concentration for U-235/236 is 0.12 pCi/L based on the maximum range of 267 U-235/236 results from aquifer samples collected from wells in the vicinity of the RWMC. Background concentrations in the soil moisture are highly variable and estimated to be 3.7, 0.7, and 1.8 pCi/L based on the mean values plus the standard deviation of the mean of 60 lysimeter samples collected at background locations. The background locations are outside of the SDA fences and are not expected to be impacted by disposed of waste.

Ratios of uranium isotopes also are expected to remain within a certain range when the uranium is naturally occurring. The U-238:U-235 activity ratio for natural uranium is 21.7. The U-238:U-235 activity ratio for slightly enriched (2%) uranium is approximately 8 and approximately 0.01 for highly enriched (greater than 93%) uranium.

3.10.1 Waste Zone

Approximately 10 mL of soil moisture was collected from Waste-Zone Lysimeter 741-08-L1 on September 8, 2003, but the volume was not sufficient to analyze for uranium isotopes; however, the sample was analyzed for gamma-emitting radionuclides with no positive detections.

3.10.2 Vadose Zone

3.10.2.1 Lysimeter Samples at Depths of 0 to 35 ft. Seventy-two isotopic uranium analyses were performed on soil-moisture samples collected from 11 shallow lysimeters in and around the SDA in FY 2003, with 52 detections above local soil-moisture background (see Table 3-24). Of the 52 results above background, 20 exceeded the 1E-05 RBC for the aquifer.

Table 3-24. Isotopic uranium results above local soil-moisture background in the 0- to 35-ft depth interval.

Location	Depth (ft)	Sample Date	Radionuclide	Sample Result ± 1σ (pCi/L)	MDA (pCi/L)	Local Soil-Moisture Background[a] (pCi/L)	Aquifer RBC[b] (pCi/L)
D15-DL07	32.2	10/21/02	U-233/234	**4.1 ± 1.1**	2.7	3.7	6.7
W08-L13	11.3	10/22/02	U-233/234	**6.5 ± 0.9**	1.2	3.7	6.7
			U-238	**2.8 ± 0.5**	0.9	1.8	5.5
W23-L07	18.8	10/21/02	U-233/234	**84 ± 7**	1.2	3.7	6.7
			U-235/236	**2.9 ± 0.6**	0.8	0.7	6.6
			U-238	**54 ± 5**	0.6	1.8	5.5
W25-L28	15.5	10/21/02	U-233/234	**4.2 ± 0.7**	1.3	3.7	6.7
			U-238	**2.4 ± 0.5**	1.1	1.8	5.5
98-4L38	17.0	10/21/02	U-233/234	**4.1 ± 0.8**	1.1	3.7	6.7
			U-238	**2.0 ± 0.5**	1.0	1.8	5.5
98-5L39	10.5	10/21/02	U-233/234	**11.4 ± 1.3**	1.1	3.7	6.7
			U-238	**8.7 ± 1.1**	1.3	1.8	5.5
W25-L28	15.5	01/06/03	U-238	**3.3 ± 0.6**[d]	0.6	1.8	5.5
PA01-L15	14.3	04/30/03	U-233/234	**34 ± 3**[c]	0.8	3.7	6.7
			U-235/236	**2.5 ± 0.5**[c]	0.6	0.7	6.6
			U-238	**22 ± 2**[d]	0.6	1.8	5.5
PA02-L16	8.7	04/30/03	U-233/234	**33 ± 3**[d]	0.5	3.7	6.7
			U-235/236	**1.7 ± 0.4**[c]	0.9	0.7	6.6
			U-238	**16.7 ± 1.7**[d]	0.6	1.8	5.5
W08-L13	11.3	04/30/03	U-233/234	**18.8 ± 1.6**[d]	0.5	3.7	6.7
			U-235/236	**1.8 ± 0.4**[c]	0.5	0.7	6.6
			U-238	**9.3 ± 1.0**[d]	0.6	1.8	5.5
W23-L07	18.8	04/28/03	U-233/234	**73 ± 6**[d]	0.9	3.7	6.7
			U-235/236	**3.1 ± 0.5**[c]	0.8	0.7	6.6
			U-238	**39 ± 3**[d]	0.5	1.8	5.5

Table 3-24. (Continued).

Location	Depth (ft)	Sample Date	Radionuclide	Sample Result ± 1σ (pCi/L)	MDA (pCi/L)	Local Soil-Moisture Background[a] (pCi/L)	Aquifer RBC[b] (pCi/L)
W23-L09	7.7	04/28/03	U-233/234	**63 ± 5**[d]	0.7	3.7	6.7
			U-235/236	**7.8 ± 0.9**[d]	0.4	0.7	6.6
			U-238	**38 ± 3**[d]	0.5	1.8	5.5
W25-L28	15.5	04/30/03	U-233/234	**4.8 ± 0.7**[c]	0.6	3.7	6.7
			U-238	**2.4 ± 0.4**[c]	0.4	1.8	5.5
98-1L35	16.5	04/30/03	U-233/234	**8.4 ± 1.0**[d]	0.6	3.7	6.7
			U-238	**7.3 ± 0.9**[d]	0.4	1.8	5.5
98-5L39	10.5	04/30/03	U-233/234	**12.4 ± 1.4**[d]	1.3	3.7	6.7
			U-238	**7.0 ± 0.9**[d]	1.0	1.8	5.5
[redacted]							
PA01-L15	14.3	07/21/03	U-233/234	**38 ± 4**[d]	0.8	3.7	6.7
			U-235/236	**3.1 ± 0.8**[c]	1.2	0.7	6.6
			U-238	**24 ± 3**[d]	0.5	1.8	5.5
PA02-L16	8.7	07/21/03	U-233/234	**29 ± 3**[d]	1.1	3.7	6.7
			U-235/236	**2.1 ± 0.6**[c]	0.9	0.7	6.6
			U-238	**16 ± 2**[d]	0.4	1.8	5.5
W08-L13	11.3	07/21/03	U-233/234	**20.4 ± 2.5**[d]	1.1	3.7	6.7
			U-235/236	**1.8 ± 0.4**[c]	0.5	0.7	6.6
			U-238	**9.3 ± 1.0**[d]	0.6	1.8	5.5
W23-L07	18.8	07/21/03	U-233/234	**71 ± 7**[d]	1.5	3.7	6.7
			U-235/236	**5.3 ± 1.1**[c]	1.1	0.7	6.6
			U-238	**38 ± 4**[d]	0.9	1.8	5.5
W23-L09	7.7	07/21/03	U-233/234	**63 ± 6**[d]	1.8	3.7	6.7
			U-235/236	**2.7 ± 0.8**[c]	1.0	0.7	6.6
			U-238	**30 ± 4**[d]	0.5	1.8	5.5
98-1-L35	16.5	07/10/03	U-233/234	**13.4 ± 1.8**[d]	1.6	3.7	6.7
			U-238	**8.1 ± 1.3**[d]	1.2	1.8	5.5

a. Local soil-moisture background concentrations for uranium isotopes are defined as the mean plus the standard deviation of the mean of 60 soil-moisture samples collected between 1998 and 2003 from the "O" and D15 lysimeter wells located outside of the SDA.
b. RBC = 1E-05 for drinking water. The RBCs for the aquifer are provided here as a basis of comparison.
c. **Black bold font** indicates sample concentrations less than the RBC, but exceeding local soil-moisture background concentrations (see footnote a).
d. **Red bold font** indicates sample concentrations that exceed the 1E-05 RBC (see footnote b).
MDA = minimum detectable activity
RBC = risk-based concentration
SDA = Subsurface Disposal Area

Concentrations of U-233/234, U-235/236, and U-238 in the 0–35-ft depth interval during FY 2003 remained relatively constant with a few exceptions. Concentrations of isotopic uranium increased in Lysimeter Wells PA01, PA02, W08, and W23 (see Figures 3-48a, 3-48b, and 3-48c) in FY 2003. However, their concentrations over the long term—even though elevated—essentially stayed constant, except for U-235/236 in Wells PA01 and W23 (see Figure 3-48b). The concentration of U-235/236 in PA01 during its 5-year monitoring history is gradually increasing, while U-233/234 and U-238 remain relatively constant. This condition produces a trend in the U-238:U-235 ratio, and the trend is suggestive of slightly enriched uranium at this monitoring location (see Figure 3-49a). Even though long-term isotopic uranium concentrations in PA02, located near PA01, appear relatively constant, the U-238:U-235 ratio also is trending toward slightly enriched uranium (see Figure 3-49b), again suggesting the presence of slightly enriched uranium at this location. Monitoring Well W23 contains two lysimeters—located at approximately an 8-ft and 19-ft depth, respectively—that show isotopic uranium results that are different than other lysimeters. The lysimeter at 19 ft (W23:L07) shows U-235/236 concentrations increasing and U-233/234 and U-238 decreasing; whereas, the lysimeter at 8 ft (W23-L09) shows a very significant long-term increase in U-235/236 with a sudden decrease in July 2003, while the concentrations of U-233/234 and U-238 remain relatively constant over the 5-year monitoring period. The only commonality between both lysimeters in Well W23 is that U-238:U-235 ratios are trending in the direction that suggests the uranium may be anthropogenic with a slight U-235 enrichment (see Figure 3-49c).

Even though U-238:U-235 activity ratios are suggesting enriched uranium, the U-234:U-238 ratios are more indicative of natural uranium. The U-234:U-238 activity ratios for these shallow lysimeters are approximately 2:1, which is drastically different than the 10:1 ratio associated with Lysimeter TW1-DL04 where enriched uranium is known to be present. The U-234:U-238 ratio of approximately 2:1 is typical of natural activity in RWMC groundwater and vadose zone soil moisture. Since records show significant quantities of depleted uranium were disposed of in the SDA, it is conjectured that its U-238 might be interfering with an accurate interpretation of isotopic uranium ratios. Confirming the presence of anthropogenic uranium and its U-235 enrichment will require high precision measurements with extremely low-level capabilities to accurately quantify U-235 and identify U-236. Such analyses can only be obtained with several mass-spectrometric methods.

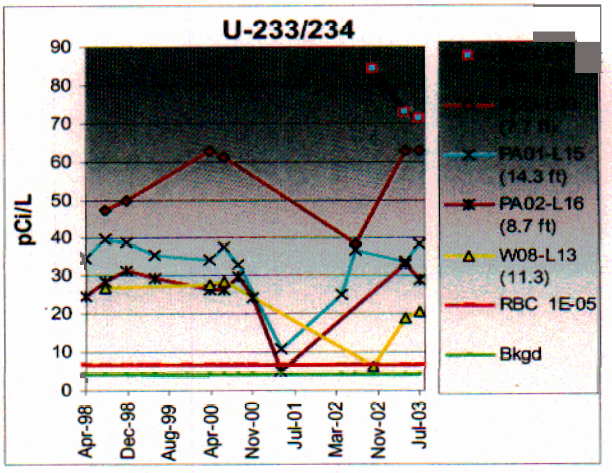

Figure 3-48a. Uranium-233/234 in select lysimeters from the shallow vadose zone, April 1998 through July 2003.

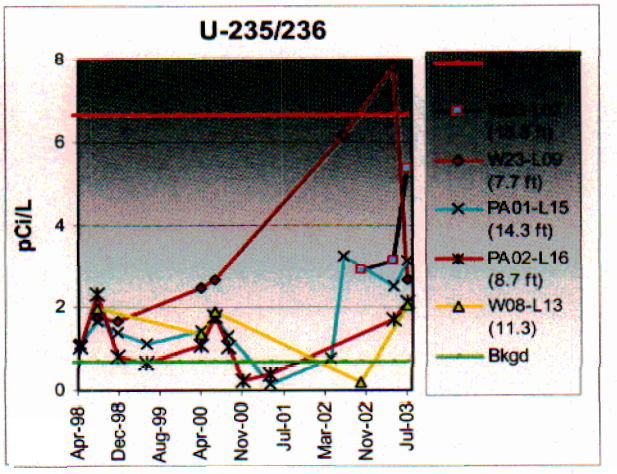

Figure 3-48b. Uranium-235/236 in select lysimeters from the shallow vadose zone, April 1998 through July 2003.

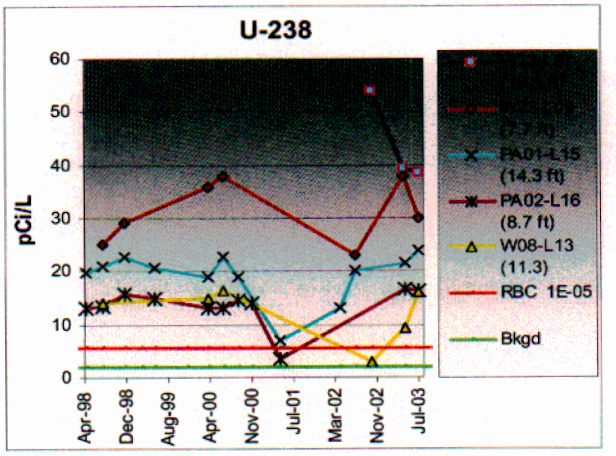

Figure 3-48c. Uranium-238 in select lysimeters from the shallow vadose zone, April 1998 through July 2003.

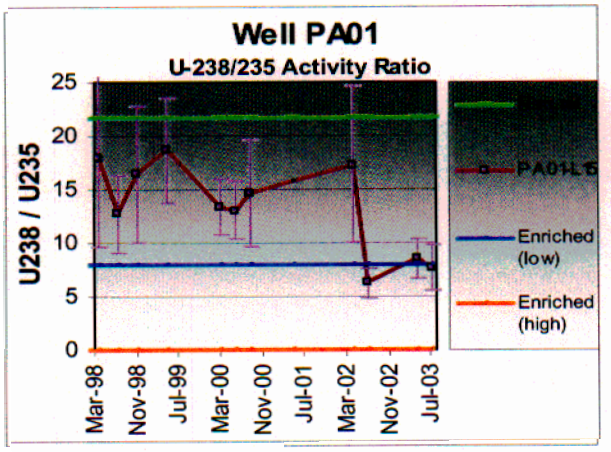

Figure 3-49a. Uranium-238/235 activity ratios for the PA01-L15 shallow lysimeter from April 1998 through July 2003.

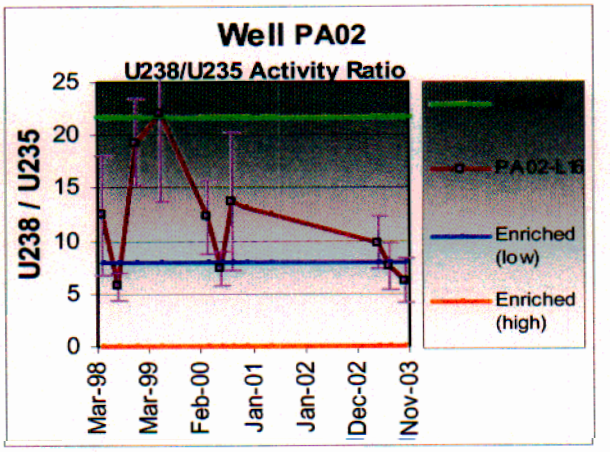

Figure 3-49b. Uranium-238/235 activity ratios for the PA02-L16 shallow lysimeter from April 1998 through July 2003.

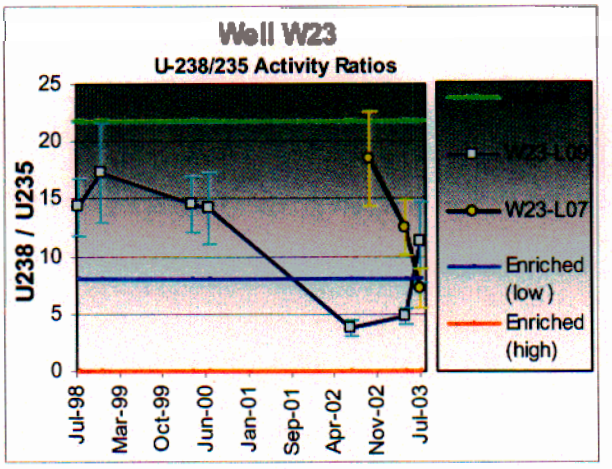

Figure 3-49c. Uranium-238/235 activity ratios for the W23-L07 and W23-L09 shallow lysimeters from August 1998 through July 2003.

3.10.2.1.1 Lysimeter Samples at Depths of 35 to 140 ft—One hundred and twenty isotopic uranium analyses were performed on soil-moisture samples collected from 13 lysimeters in and around the SDA in FY 2003, with 35 detections above local soil-moisture background (see Table 3-25). Of the 35 results above background, 21 exceeded the 1E-05 RBC for the aquifer.

Table 3-25. Isotopic uranium results above local soil-moisture background in the 35- to 140-ft depth interval.

Location	Depth (ft)	Sample Date	Radionuclide	Sample Result ± 1σ (pCi/L)	MDA (pCi/L)	Local Soil-Moisture Background[a] (pCi/L)	Aquifer RBC[b] (pCi/L)
I1S-DL09	101	10/21/02	U-233/234	**20.8 ± 2.1**	1.3	3.7	6.7
			U-238	**9.9 ± 1.3**	1.2	1.8	5.5
I4S-DL15	97	10/22/02	U-233/234	**4.4 ± 0.7**	0.7	3.7	6.7
			U-235/236	**1.7 ± 0.4**	0.5	0.7	6.6
			U-238	**2.4 ± 0.5**	0.2	1.8	5.5
TW1-DL04	101.7	10/22/02	U-233/234	**57 ± 5**	0.9	3.7	6.7
			U-235/236	**1.8 ± 0.5**	0.9	0.7	6.6
			U-238	**5.1 ± 0.8**	0.9	1.8	5.5
I1S-DL09	101	04/29/03	U-233/234	**16.9 ± 2.1**[c]	1.0	3.7	6.7
			U-238	**8.4 ± 1.3**[c]	0.7	1.8	5.5
W25-L28	15.5	01/06/03	U-238	**3.3 ± 0.6**[d]	0.6	1.8	5.5
D06-DL01	88	04/29/03	U-233/234	**86 ± 6**[d]	0.6	3.7	6.7
			U-235/236	**10.3 ± 1.0**[d]	0.2	0.7	6.6
			U-238	**44 ± 3**[d]	0.5	1.8	5.5
D06-DL02	44	04/29/03	U-233/234	**97 ± 7**[d]	0.8	3.7	6.7
			U-235/236	**17.0 ± 1.5**[d]	0.9	0.7	6.6
			U-238	**39 ± 3**[d]	0.8	1.8	5.5
I1S-DL09	101	04/29/03	U-233/234	**15.8 ± 1.5**[d]	1.3	3.7	6.7
			U-238	**9.9 ± 1.0**[d]	0.4	2.1	5.5
I4S-DL15	97	04/29/03	U-233/234	**8.4 ± 0.9**[d]	0.6	3.7	6.7
			U-238	**4.7 ± 0.6**[c]	0.4	1.8	5.5
O2-DL20	106	05/01/03	U-233/234	**5.0 ± 0.7**[c]	0.8	3.7	6.7
			U-238	**2.7 ± 0.5**[c]	0.5	1.8	5.5
D06-DL01	88	7/10/03	U-233/234	**100 ± 10**[d]	0.5	3.7	6.7
			U-235/236	**6.0 ± 1.0**[c]	0.9	0.7	6.6
			U-238	**45 ± 5**[d]	0.5	1.8	5.5
I1S-DL09	101	7/22/03	U-233/234	**14.4 ± 1.9**[d]	0.4	3.7	6.7
			U-238	**8.3 ± 1.3**[d]	0.8	1.8	5.5
I4S-DL15	97	7/21/03	U-233/234	**7.0 ± 1.2**[d]	1.3	3.7	6.7
			U-238	**4.2 ± 0.9**[c]	1.1	1.8	5.5
TW1-DL04	101.7	7/21/03	U-233/234	**101 ± 9**	0.9	3.7	6.7
			U-235/236	**4.8 ± 0.9**[c]	0.8	0.7	6.6
			U-238	**9.3 ± 1.4**[c]	0.8	1.8	5.5

Table 3-25. (continued).

Location	Depth (ft)	Sample Date	Radionuclide	Sample Result ± 1σ (pCi/L)	MDA (pCi/L)	Local Soil-Moisture Background[a] (pCi/L)	Aquifer RBC[b] (pCi/L)

a. Local soil-moisture background concentrations for uranium isotopes are defined as the mean plus the standard deviation of the mean of 60 soil-moisture samples collected between 1998 and 2003 from the "O" and D15 lysimeter wells located outside of the SDA.
b. RBC = 1E-05 for drinking water. The RBCs for the aquifer are provided here as a basis of comparison.
c. **Black bold font** indicates sample concentrations less than the RBC, but exceeding local soil-moisture background concentrations (see footnote a).
d. **Red bold font** indicates sample concentrations that exceed the 1E-05 RBC (see footnote b).
MDA = minimum detectable activity
RBC = risk-based concentration
SDA = Subsurface Disposal Area

Isotopic uranium concentrations in the SDA at intermediate depths appear fairly constant, except for Monitoring Well D06 and TW1. Uranium concentrations in these wells are very elevated, while concentrations over the past 5 years remain fairly constant, except for U-235 in Wells PA01 and W23 (see Figures 3-48). The concentration of U-235 in PA01 during its 5-year monitoring history is gradually increasing, while U-234 and U-238 are remaining relatively constant. This scenario is generating a U-238/U-235 activity ratio trend suggestive of slightly enriched uranium (see Figure 3-49a). Even though long-term isotopic uranium concentrations in PA02, located near PA01, appear relatively constant, the U-238/U-235 activity ratio also is trending toward slightly enriched uranium (see Figure 3-49b). Well W23 contains two lysimeters—located at approximately 8 ft and 19 ft, respectively—that are showing isotopic uranium results that are different than other lysimeters. The lysimeter at 19 ft (W23:L07) shows U-235 concentrations increasing and U-234 and U-238 decreasing, whereas the lysimeter at 8 ft (W23-L09) shows a sudden decrease in U-235, while the concentrations of U-234 and U-238 are relatively constant. The similarity with both lysimeters is that U-238/U-235 activity ratios, which are constant in nature, are trending and suggesting uranium might be anthropogenic with a slight U-235 enrichment (see Figure 3-49).

Concentrations of U-233/234, U-235/236, and U-238 in the 35–140-ft depth interval in FY 2003 remained relatively constant with a few exceptions. Concentrations of uranium isotopes increased in Lysimeter TW1-DL04 during FY 2003 but essentially stayed constant over the entire 6-year monitoring period (see Figures 3-50a, 3-50b, and 3-50c). The U-238:U-235 ratio also stayed constant (see Figure 3-51b), further demonstrating that anthropogenic uranium with a slight U-235 enrichment exists at the TW1 monitoring location. Uranium results obtained from Lysimeters D06-DL01 and D06-DL02 in FY 2003 show an increase in U-235/236, while U-233/234 and U-238—even though elevated—remained relatively constant or decreased to some extent (see Figures 3-50a, 3-50b, and 3-50c). As shown in Figure 3-51a, the U-238:U-235 ratio for Lysimeters D06-DL01 and D06-DL02 are trending downward because of increasing U-235 activity over time, and the trends are suggestive of slightly enriched uranium. Although the U-234:U-238 ratios in Well D06-DL02 are still within the expected range for natural uranium, increasing U-234 coupled with increasing U-235 suggests that enriched uranium is impacting the soil moisture at this location (near Pad A).

Even though U-238:U-235 activity ratios are suggesting enriched uranium, the U-234:U-238 ratios are more indicative of natural uranium. The U-234:U-238 activity ratios for these shallow lysimeters are approximately 2:1, which is drastically different than the 10:1 ratio associated with Lysimeter TW1-DL04 where enriched uranium is known to be present. The U-234:U-238 ratio of approximately 2:1 is typical of natural activity in RWMC groundwater and vadose zone soil moisture. Since records show significant quantities of depleted uranium were disposed of in the SDA, it is conjectured that its U-238 might be interfering with an accurate interpretation of isotopic uranium ratios. To absolutely confirm the presence of anthropogenic uranium and its U-235 enrichment will require high precision measurements with

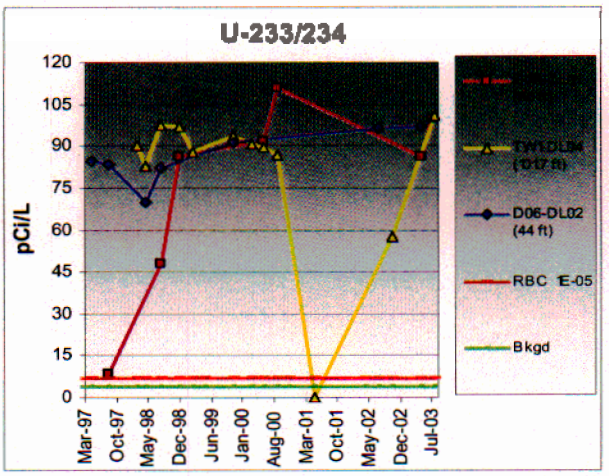

Figure 3-50a. Uranium-233/234 in mid-depth lysimeters, March 1997 through July 2003.

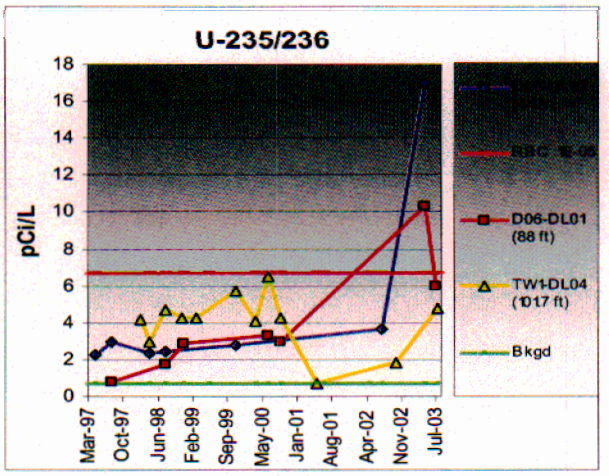

Figure 3-50b. Uranium-235/236 in mid-depth lysimeters, March 1997 through July 2003.

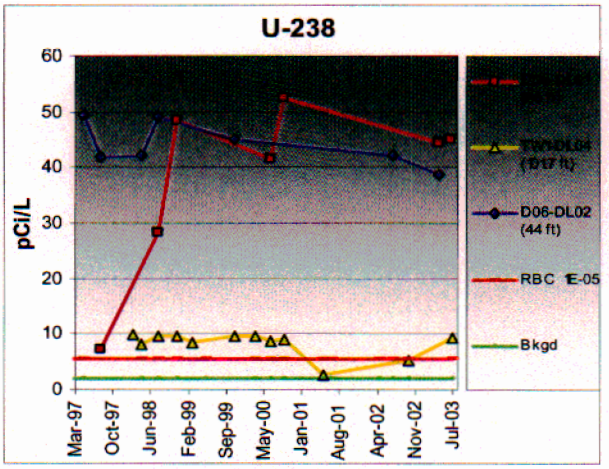

Figure 3-50c. Uranium-238 in mid-depth lysimeters, March 1997 through July 2003.

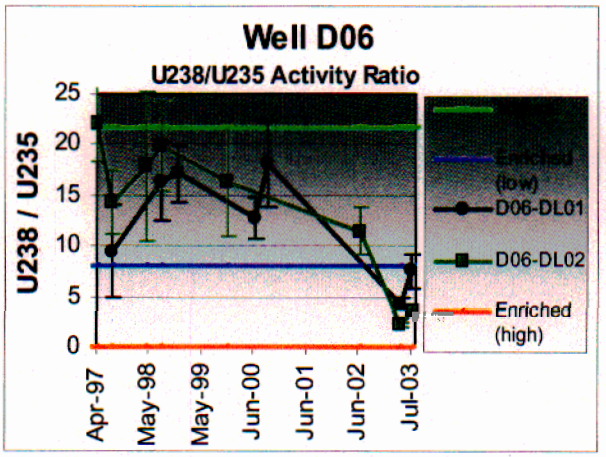

Figure 3-51a. Uranium-238:235 activity ratio in D06-DL01 and D06-DL02 over time.

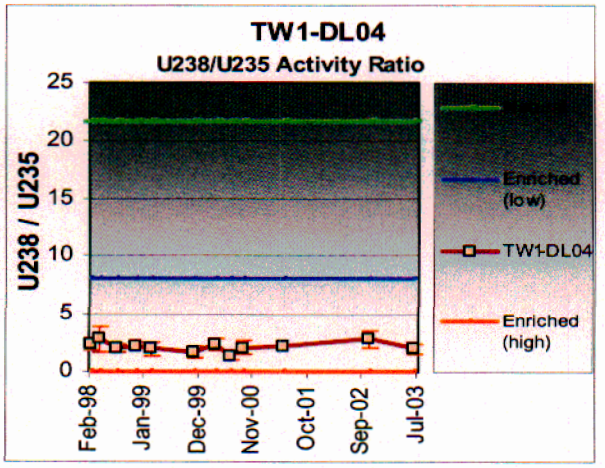

Figure 3-51b. Uranium-238:235 activity ratio in TW1-DL04 over time.

extremely low-level capabilities to accurately quantify U-235 and identify U-236. Trends are not apparent in lysimeters elsewhere in the SDA, although all uranium isotopes measured in Well I1S on the west end of the SDA are relatively high. Well I1S is located near Well W23, which yielded samples high in uranium from the shallow vadose zone.

3.10.2.2 Lysimeter and Perched Water Samples at Depths Greater than 140 ft. Sixty-nine isotopic uranium analyses were performed on soil-moisture and perched water samples collected from six lysimeters and two perched wells in and around the SDA in FY 2003, with six detections slightly above local soil-moisture background (see Table 3-26). None of the six results above local soil-moisture background exceeded the 1E-05 RBC for the aquifer. It does not appear as though there has been an anthropogenic impact to soil moisture at this depth and location within the SDA. Historical U-233/234 and U-238 data from Well USGS-92 (65 m [214 ft] deep) are depicted in Figures 3-52a and 3-52b. Perched water samples from Well USGS-92 often exceed background concentrations for U-233/234 and U-238; however, the data show no constant trends.

Table 3-26. Isotopic uranium results above local soil-moisture background in the 140- to 250-ft depth interval.

Location	Depth (ft)	Sample Date	Radionuclide	Sample Result ± 1σ (pCi/L)	MDA (pCi/L)	Local Soil-Moisture Background[a] (pCi/L)	Aquifer RBC[b] (pCi/L)
O2D:DL19	240	10/21/02	U-233/234	**4.7 ± 0.8**[c]	0.8	3.7	6.7
			U-238	**3.0 ± 0.6**[c]	0.8	1.8	5.5
USGS-92	214	10/22/02	U-233/234	**4.4 ± 0.8**[c]	0.9	3.7	6.7
			U-238	**3.7 ± 0.7**[c]	1.2	1.8	5.5
USGS-92	214	01/08/03	U-238	**2.1 ± 0.4**[c]	0.4	1.8	5.5
USGS-92	214	07/22/03	U-238	**2.6 ± 7**[c]	0.4	1.8	5.5

a. Local soil-moisture background concentrations for uranium isotopes are defined as the mean plus the standard deviation of the mean of 60 soil-moisture samples collected between 1998 and 2003 from the "O" and D15 lysimeter wells located outside of the SDA.
b. RBC = 1E-05 for drinking water. The RBCs for the aquifer are provided here as a basis of comparison.
c. **Black bold font** indicates sample concentrations less than the RBC, but exceeding local soil-moisture background concentrations (see footnote a).
MDA = minimum detectable activity
RBC = risk-based concentration
SDA = Subsurface Disposal Area
USGS = United States Geological Survey

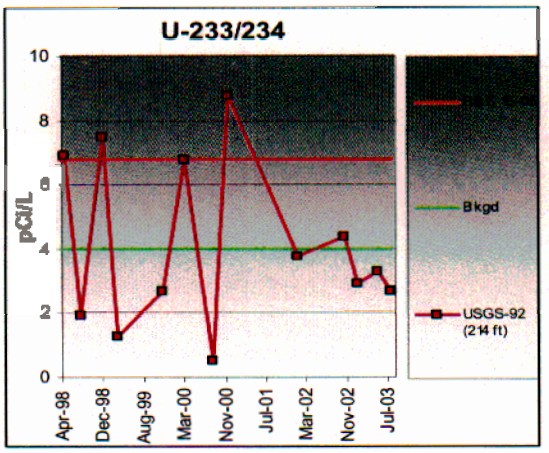

Figure 3-52a. Uranium-233/234 data from Well USGS-92, April 1998 through July 2003.

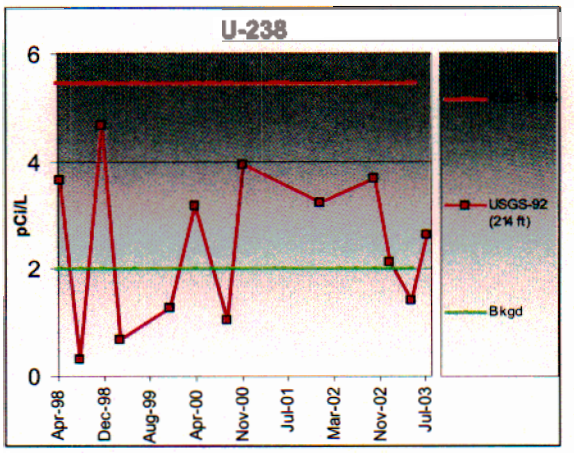

Figure 3-52b. Uranium-238 data from Well USGS-92, April 1998 through July 2003.

3.10.3 Aquifer

One hundred and eighty-nine isotopic uranium analyses were performed on aquifer samples collected from 15 monitoring wells in the vicinity of the RWMC in FY 2003, with four positive detections. All isotopic uranium concentrations were within concentration ranges typically observed in the SRPA, with the exception of three U-235/236 results and one U-233/234 result (see Table 3-27). None of the results exceeded the 1E-05 aquifer RBCs for each uranium isotope. The elevated U-235/236 concentrations were measured in samples collected from Monitoring Wells M15S, M16S, and OW2.

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Well	Sample Date	Radionuclide	Sample Result ± 1σ (pCi/L)	MDA (pCi/L)		RBC[b]
	02/04/03	U-235/236	**0.14 ± 0.02**[c]	0.04		
M16S	04/30/03	U-235/236	**0.15 ± 0.02**[c]	0.04	0.12	6.63
OW2	08/05/03	U-233/234	**2.01 ± 0.18**[c]	0.06	1.92	6.74
M15S	08/05/03	U-235/236	**0.26 ● 0.04**[c]	0.04	0.12	6.63

Uranium detected in the aquifer in the vicinity of the RWMC is typical of naturally occurring uranium in the SRPA. In FY 2003, slightly elevated concentrations of U-233/234 in Aquifer Well OW2 and U-235/236 in Wells M15S, M16S, and OW2 appear to be anomalous, because all other quarterly sampling results for FY 2003 show U-233/234 and U-235/236 to be representative of aquifer background concentrations. A summary of the maximum detected concentrations of U-233/234 and U-238 in aquifer samples since FY 1997 are presented in Tables 3-28 and 3-29, respectively.

Table 3-28. Summary of maximum detected concentrations of uranium-233/234 from aquifer wells in the vicinity of the Radioactive Waste Management Complex since Fiscal Year 1997.[a]

Fiscal Year [b]	Maximum Concentration ± 1σ (pCi/L)	Well Location
1997	NA[c]	—
1998	1.65 ± 0.16	M3S
1999	1.54 ± 0.13	M12S
2000	1.6 ± 0.2	M14S
2001	4.3 ± 0.4	M14S
2002	1.68 ± 0.14	M4D
2003	2.01 ± 0.18	OW-2

a. MCL = 27 pCi/L (total uranium)
b. Fiscal year spans from October 1 to September (e.g., Fiscal Year 1997 is October 1, 1996, to September 30, 1997).
c. No samples were analyzed for U-233/234.
MCL = maximum contaminant level

Table 3-29. Summary of maximum detected concentrations of uranium-238 from aquifer wells in the vicinity of the Radioactive Waste Management Complex since Fiscal Year 1997.[a]

Fiscal Year [b]	Maximum Concentration ● 1σ (pCi/L)	Well Location
1997	NA	—
1998	0.74 ± 0.08	M7S
1999	0.75 ± 0.07	M12S
2000	0.72 ± 0.11	M3S
2001	2.1 ± 0.2	M14S
2002	0.78 ± 0.08	M4D
2003	0.90 ± 0.10	A11A31

a. MCL = 27 pCi/L (total uranium)
b. Fiscal year spans from October 1 to September (e.g., Fiscal Year 1997 is October 1, 1996, to September 30, 1997).
c. Not analyzed
MCL = maximum contaminant level

3.10.4 Summary of Uranium

Uranium levels measured in FY 2003 in numerous vadose zone soil-moisture samples significantly exceed local soil-moisture background levels and RBCs for water ingestion. The soil-moisture detections of uranium above RBCs are depicted in Figure 3-53 with the locations of uranium disposals based on disposal records. Maximum concentrations detected in soil-moisture and perched water samples are presented in Tables 3-30 and 3-31. Some locations are where multiple detections of uranium correlate with disposal locations, suggesting that uranium might be a potential candidate for model validation or

comparison. In the Pad A area, uranium is detected above background levels in all lysimeters above 30 m (100 ft), but has not been measured above background levels at Well I-4D (at 59 m [226.5 ft]). Most interesting is that uranium has been repeatedly detected above background in Well I-4S at the 29.6-m (97-ft) depth (Well I-4S), suggesting that uranium might have migrated to the first B-C interbed, but might not have reached the C-D interbed yet at 67 m (220 ft). Wells D06 and PA01 from the Pad A area routinely contain elevated uranium concentrations and are indicative of enriched uranium.

Table 3-30. Summary of maximum detections of uranium-238 in vadose zone soil-moisture and perched water samples at the Radioactive Waste Management Complex from Fiscal Year 1997 through 2003.[a]

Sampling Range (feet below land surface)	Fiscal Year[b]	Maximum Concentration ± 1σ (pCi/L)[c,d]	Sample Location
Lysimeters 0 to 35 ft	1997	34 ± 3	PA03-L33
	1998	40 ± 3	PA03-L33
	1999	**41 ± 3**	PA03-L33
	2000	**46 ± 3**	W23-L08
	2001	**53 ± 5**	W23-L08
	2002	53 ± 4	W06-L27
	2003	54 ± 5	W23-L07
Lysimeters 35 to 140 ft	1997	49 ± 4	D06-DL02
	1998	49 ± 4	D06-DL02
	1999	49 ± 3	D06-DL01
	2000	53 ± 5	D06-DL01
	2001	4.7 ± 1.0	O3-DL22
	2002	9.4 ± 1.1	I1S-DL09
	2003	45 ± 5	D06-DL01
Lysimeters >140 ft	1997	NA	—
	1998	NA	—
	1999	NA	—
	2000	NA	—
	2001	NA	—
	2002	NA	—
	2003	3.0 ± 0.6	O2-DL19
Perched water wells >140 ft	1997	NA	—
	1998	3.6 ± 1.1	USGS-92
	1999	4.7 ± 0.4	USGS-92
	2000	3.2 ± 0.4	USGS-92
	2001	NA	—
	2002	NA	—
	2003	3.7 ± 0.7	USGS-92

a. MCL = 27 pCi/L (total uranium)
b. Fiscal year spans from October 1 to September (e.g., Fiscal Year 1997 is October 1, 1996, to September 30, 1997).
c. NA = not analyzed ND = not detected
d. Local soil-moisture background for U-233/234 is 1.5 pCi/L based on soil-moisture samples collected outside the SDA (Holdren et al. 2002).
MCL = maximum contaminant level
SDA = Subsurface Disposal Area
USGS = United States Geological Survey

Table 3-31. Summary of maximum detections of uranium-233/234 in vadose zone soil-moisture and perched water samples at the Radioactive Waste Management Complex from Fiscal Year 1997 through 2003.[a]

Sampling Range (feet below land surface)	Fiscal Year[b]	Maximum Concentration ± 1σ (pCi/L)[c,d]	Sample Location
Lysimeters 0 to 35 ft	1997	43 ± 3	PA03-L33
	1998	60 ± 4	W23-L08
	1999	57 ± 4	PA03-L33
	2000	76 ± 5	W23-L08
	2001	87 ± 8	W23-L08
	2002	125 ± 10	W06-L27
	2003	84 ± 7	W23-L07
Lysimeters 35 to 140 ft	1997	84 ± 6	D06-DL02
	1998	97 ± 7	TW1-DL04
	1999	90 ± 14	TW1-DL04
	2000	111 ± 10	D06-DL01
	2001	7.3 ± 1.3	O3-DL22
	2002	17.3 ± 1.7	I1S-DL09
	2003	101 ± 9	TW1-DL04
Lysimeters >140 ft	1997	NA	—
	1998	NA	—
	1999	NA	—
	2000	NA	—
	2001	NA	—
	2002	9 ± 0.4	I4D-DL14
	2003	4.7 ± 0.8	O2D-DL19
Perched water wells >140 ft	1997	NA	—
	1998	NA	—
	1999	7.5 ± 0.6	USGS-92
	2000	6.7 ± 0.7	USGS-92
	2001	NA	—
	2002	NA	—
	2003	4.4 ± 0.8	USGS-92

a. MCL = 27 pCi/L (total uranium)
b. Fiscal year spans from October 1 to September (e.g., Fiscal Year 1997 is October 1, 1996, to September 30, 1997).
c. NA = not analyzed ND = not detected
d. Local soil-moisture background for U-233/234 is 3 pCi/L based on soil-moisture samples collected outside the SDA (Holdren et al. 2002).
MCL = maximum contaminant level
SDA = Subsurface Disposal Area
USGS = United States Geological Survey

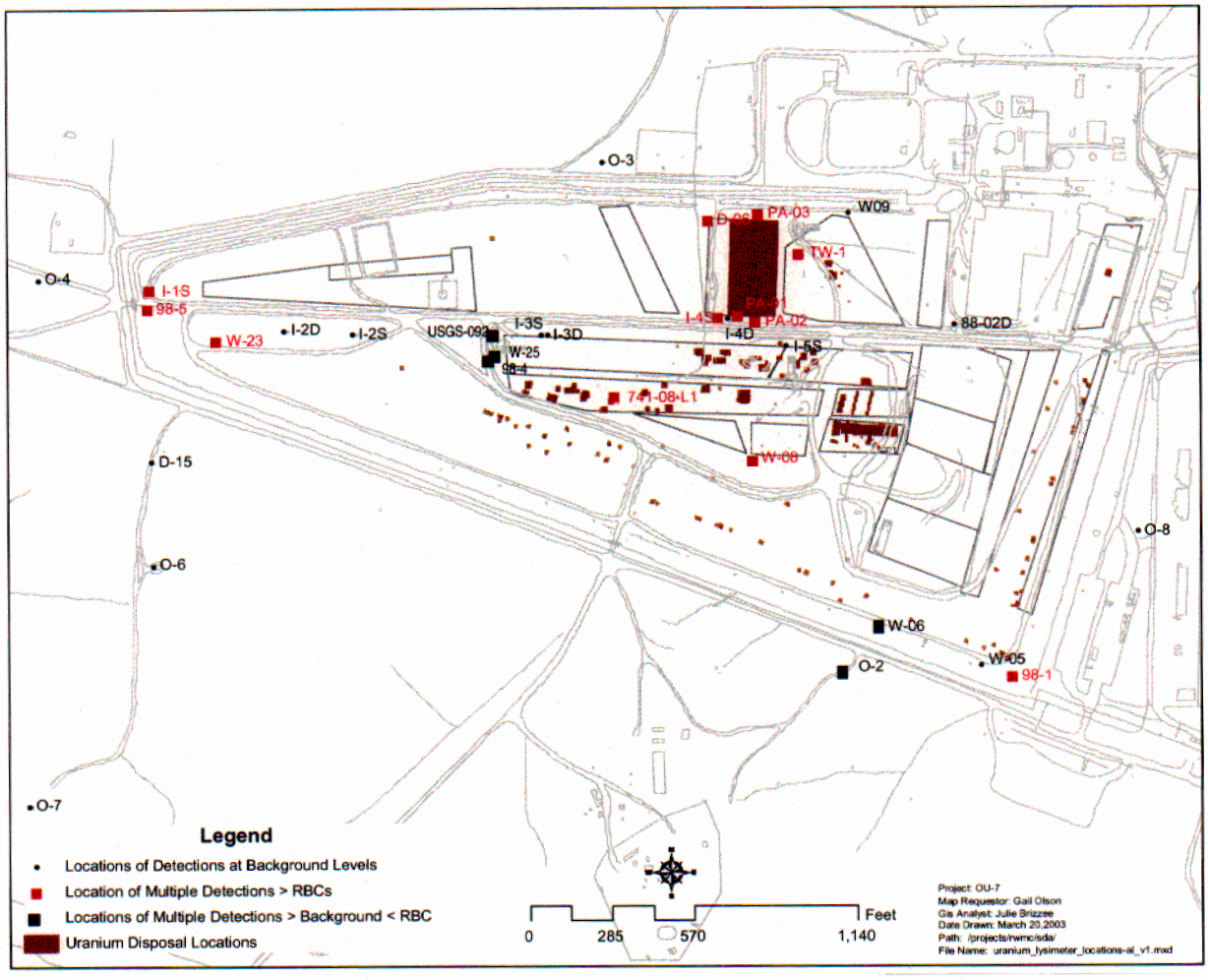

Figure 3-53. Uranium disposal locations and vadose zone detection locations at the Subsurface Disposal Area.

Uranium concentrations at the west end of the SDA also are significantly above background in Lysimeter Wells 98-5, I-1S, and W23 with concentration and isotopic ratio trends in Well W23; however, no uranium disposals have been recorded in that area. Therefore, the uranium monitoring data cannot be used for model calibration, which starts in the source term with the inventory records; however, the uranium trends in the western end of the SDA highlight some limitations and uncertainties of the inventory records.

3.11 Other Radionuclide Contaminants

All waste zone, vadose zone, and aquifer samples were analyzed for 20 or more gamma-emitting radionuclides, and there was only one detection. A positive detection of Cs-137 was reported in the third quarter aquifer sample pulled from Well M7S. No Cs-137 was detected in the subsequent quarter from the same well.